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research division

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PARTIAL DISCHARGE MONITOR FOR DARLINGTON PRIMARY HEAT TRANSPORT PUMP MOTORS

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Partial Discharge (PD) measurements and Megger tests are good indicators of the insulation condition of a motor. It is therefore desirable to facilitate such testing on the Primary Heat Transport Pump (PHTP) motors to be installed at Darlington NGS. Minor changes to the grounding of the surge capacitors is all that is necessary to enable easy testing of these motors. This report describes the modifications required. With these modifications, the partial discharge test can be done during normal motor operation.

A request was made by Darlington Engineering for a procedure to simplify Megger testing and Partial Discharge monitoring of the Darlington PHTP motors. A procedure has been developed which will require minor modifications to the motor, yet will result in making both tests less expensive as well as less time consuming.

With the suggested changes, the partial discharge pulses can be detected with an inexpensive high frequency current transformer (CT) permanently mounted on the common ground of the motor's surge capacitors/1/. Partial discharge pulses appearing on any phase of the motor during normal operation will cause high-frequency currents to flow through the surge capacitor to ground. These currents can be measured with a high-frequency CT connected to an oscilloscope. A skilled observer is required to distinguish between pulses due to partial discharges and system noise, and to estimate their magnitude. To insure maximum sensitivity, the surge capacitors must have a single ground. Thus, the capacitor cases must be insulated from ground, which requires some minor changes to the existing surge capacitor mounting arrangement.

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The Megger test requires the removal of the surge capacitors from the motor terminals. This can be effectively accomplished by disconnecting the ground side of the capacitors from ground for the duration of the Megger test. The same modifications needed for the Partial Discharge test, will facilitate the Megger test, by providing a single easy-to-remove capacitor ground link.

A procedure to make the required modifications to the motor surge capacitors is described in attached Appendix.

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Submitted by:

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Stations and Underground Section

GLF JAD:lag/am/msf

Reference

1. G.C. Stone, "Monitoring of Partial Discharge Activity in Heat Transport Pump Motors," Research Division Report 83-511-K, Dec. 1983.

APPENDIX

INSTRUCTIONS FOR INSULATING SURGE CAPACITORS AND INSTALLING RF MONITORING EQUIPMENT ON DARLINGTON HEAT TRANSPORT PUMP MOTORS

OBJECTIVES:

1. Insulate the three surge capacitor cases from ground. These capacitors are installed in the motor terminal box.

2. Weld CT support bracket and ground block terminal to outside of terminal box.

3. Make a connection from CT to coaxial cable and install new ground lead on capacitors.

4. Make modifications to give easy access for station staff to facilitate "Megger" testing of the motor without removing the high voltage leads of the three capacitors.

Objective #1: Insulating Capacitors

a) Grind weld which secures the six bolts holding the three capacitors to the top of the terminal box (Figure 1).

b) Place a "C" clamp on the mounting bracket of the capacitor and the outside of the terminal box (Figure 1).

c) Loosen nut "A" on capacitor that has been clamped (Figure 1).

d) If weld not completely broken from step (a) take a hammer and chisel and free bolt from terminal box weld.

e) Remove nut and bolt at "A".

f) Front of capacitor should now be supported by a "C" clamp. The "C" clamp should have enough clearance so that a 3/4" hole can be drilled where the welded bolt was. Drill the 3/4" hole at "A".

g) Temporarily insert 3/8" x 1-1/4" bolt at "A" and tighten with appropriate nut to support the capacitor. Remove the "C" clamp.

h) Cut a piece of 1" x 2" wood to length to put in as a brace between the capacitor and the copper bus bar (Figure 1). This will help relieve the tension on the capacitor terminal post.

i) Insulating boards have been provided to insulate the metal capacitor from the terminal box. These boards are 17-1/2" x 5" with one 3/4" hole drilled. The board is 1/8" thick.

j) Remove the bolt and nut from the back of the capacitor at point "B" (Figure 1). Then carefully remove the bolt and nut from point "A". You should now be able to slide one board between the capacitor and the top of the box (Figure 2). The 3/4" hole in the insulating board should be at point "A" (Figure 1).

k) Insert the supplied PVC washer as shown in Figure 3 and re-install the nut and bolt as well as washers and lock washers to support the point "A" end of the capacitor.

l) Enlarge bolt hole at "B" to 3/4". Note that the hole is drilled through the insulating board. Put in PVC insert at Point B and fasten this end of the capacitor with a nut and bolt. Remove the wood brace. Make sure all bolts are tight.

m) Repeat steps (a) to (l) on the other 2 capacitors.

Objective #2: Attach CT Support Bracket and Ground Block Terminal

a) Drill a hole in the side of the terminal box where the original ground is connected to accommodate a 1" box connector. The approximate location for the hole is 12" down from the top and 16" in from the front opening (Figure 4). Install the 1" box connector.

b) Layout position for mounting of ground block terminal. With one continuous weld, attach the supplied steel ground block to the terminal box as shown in Figure 4.

c) Attach the CT support bracket (the supplied steel U-shaped bracket) as in Figure 5. Weld in place with two welds, one side only. Care should be taken in making sure that the hole in the CT support bracket lines up with the hole in the terminal box (see Figure 5). The bracket comes with holes predrilled for the ground lead as well as to support the CT core.

Objective #3: Connect CT to Coax Cable and Install Ground

a) Drill a 3/4" hole 12" down from the top of the shroud support and 6" to the right of the box with the elbow connectors in them (Figure 6).

b) A plate is supplied with a BNC connector mounted on it. A length of coax cable is connected to this connector with a 1 kΩ resistor soldered from the centre conductor to ground. This connection point has been potted in RTV. Feed the length of coax through the 3/4" hole from step (a). The plate has 4 holes predrilled for mounting. Mark the holes and drill 4, 11/64" holes to accommodate 10-32 screws.

c) Remove the paint from the area under this plate, to ensure that the plate is making good electrical contact to the metal of the shroud base. Mount the plate (Figure 7).

d) The coax cable from the connector should be laid out to connect to the CT with enough slack to allow the cable to be supported on the terminal box (Figure 8).

e) Cut the coax cable to the proper length for proper mounting. After cutting, cut the black jacket only, back about one inch on the coax cable. Then cut the shield of the coax cable along one side to where the jacket was cut. Separate shield from the insulation. Twist shield into a separate lead parallel to the insulation. Next cut the insulation on the conductor back 1/2" and remove the insulation (Figure 9).

f) Solder the center conductor of the coax to one of the white leads of the CT winding. It doesn't matter which white lead is used. After soldering, tape this connection so that it is insulated and cannot be shorted out. Then solder the coax shield to the other white lead. Insulate this connection as well (Figure 9).

g) Fold these leads across the turns of the winding so that a cable tie can be used to support these leads to the CT core (Figure 10).

h) Secure CT core to support bracket with the orange rubber cutout between them. Use the 4 cable ties provided (Figure 11).

i) Secure the coax cable from the CT to the BNC connector by using adhesive backed cable tie mounts and cable ties attached to the terminal box. The ties and mounts are supplied.

j) Remove the existing capacitor ground lead. Connect the supplied 1-1/2' long 2/0 insulated ground lead to the same point of the capacitor. Thread the ground lead through the hole in the terminal box, the window in the CT core and the hole in the CT support bracket. Connect the other end of the ground lead to the outside ground block (Figures 8, 11). The two bolts and plate used in bolting the original inside ground should be used in securing the new ground.

k) Tighten down the two screws on each box connector, securing the ground lead in a rigid position.

Objective #4: Megger Test Procedure

During a suitable motor outage, the insulation resistance of the motor can be measured. The capacitors are removed from the test circuit by disconnecting them from ground (Figure 12). The Megger test then proceeds as normal.

a) Disconnect the ground lead from the ground block on the outside of the terminal box (Figure 7) and leave floating.

b) Access must be made to a point on the motor winding where a clip can be attached from the Megger to the motor. Clean the area marked 1 on Figure 13 of any insulation so that contact can be made to the metal. This only needs to be done on one capacitor.

c) Connect Megger test leads between the one capacitor connection that has been cleaned (step (b) above) and any motor ground point.

d) Do the Megger test at 1000v dc. After testing, the capacitor terminal should be reinsulated. Use six layers of SAPT tape and one layer of silicone tape over the SAPT. Reconnect the ground to the terminal box.

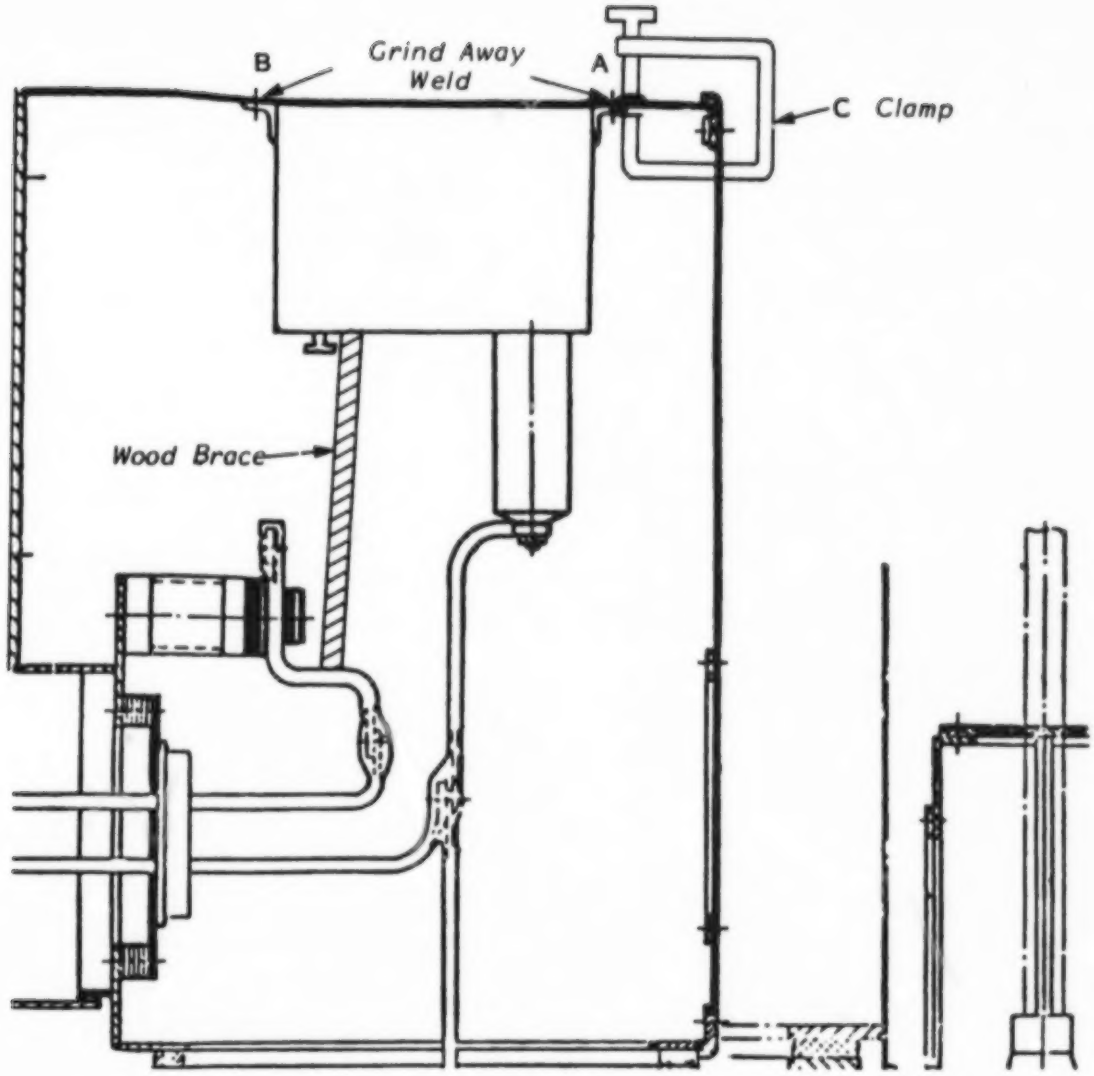

FIGURE 1
CAPACITOR SUPPORTS

174655-RD
86-357

Figure 2

Illustrates the three insulating boards at Point A

Figure 3

A close-up of the insulating board and washer assembly at Point A.
(Insulation is similar at point B)

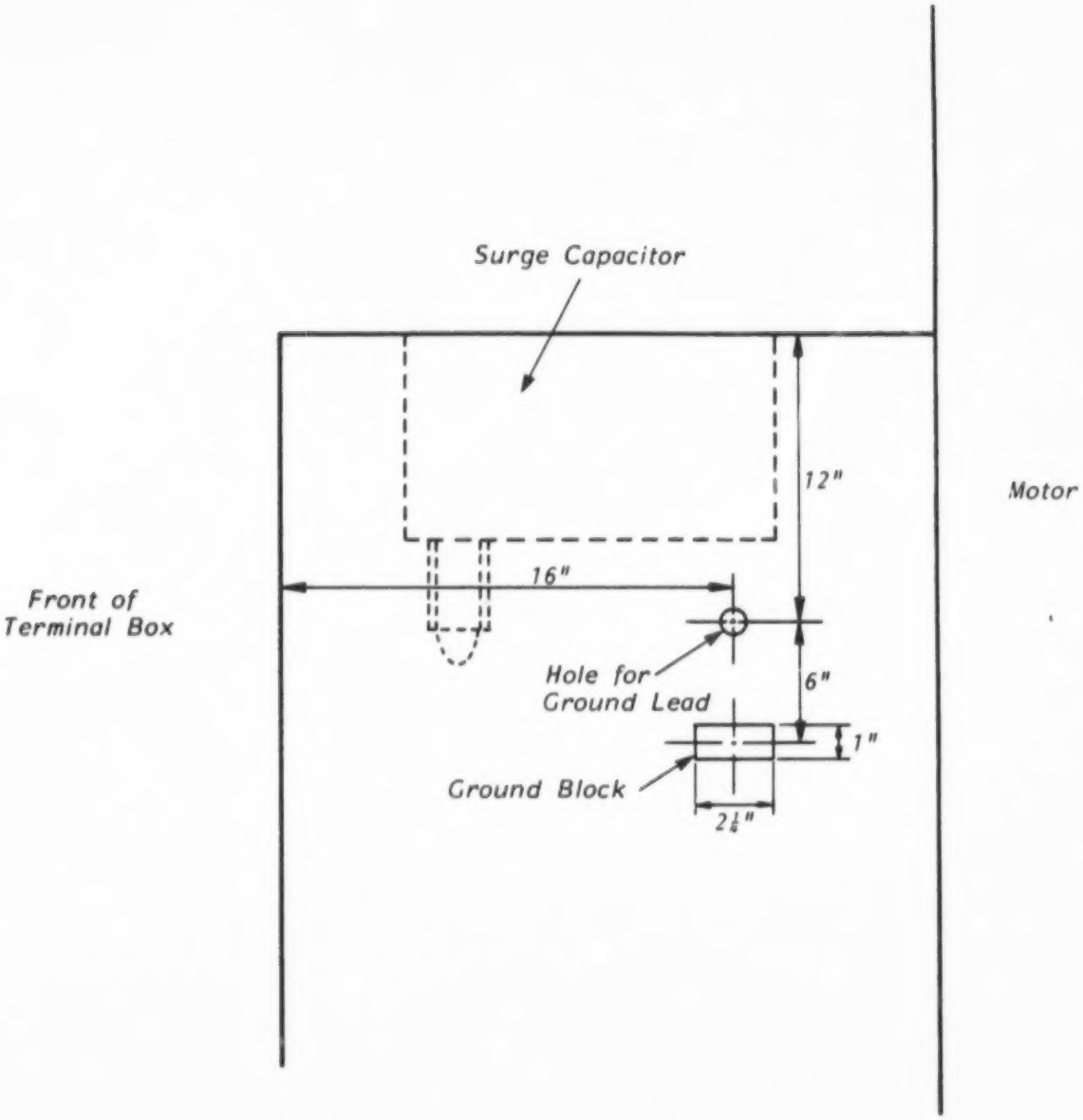

FIGURE 4
TERMINAL BOX SIDE VIEW

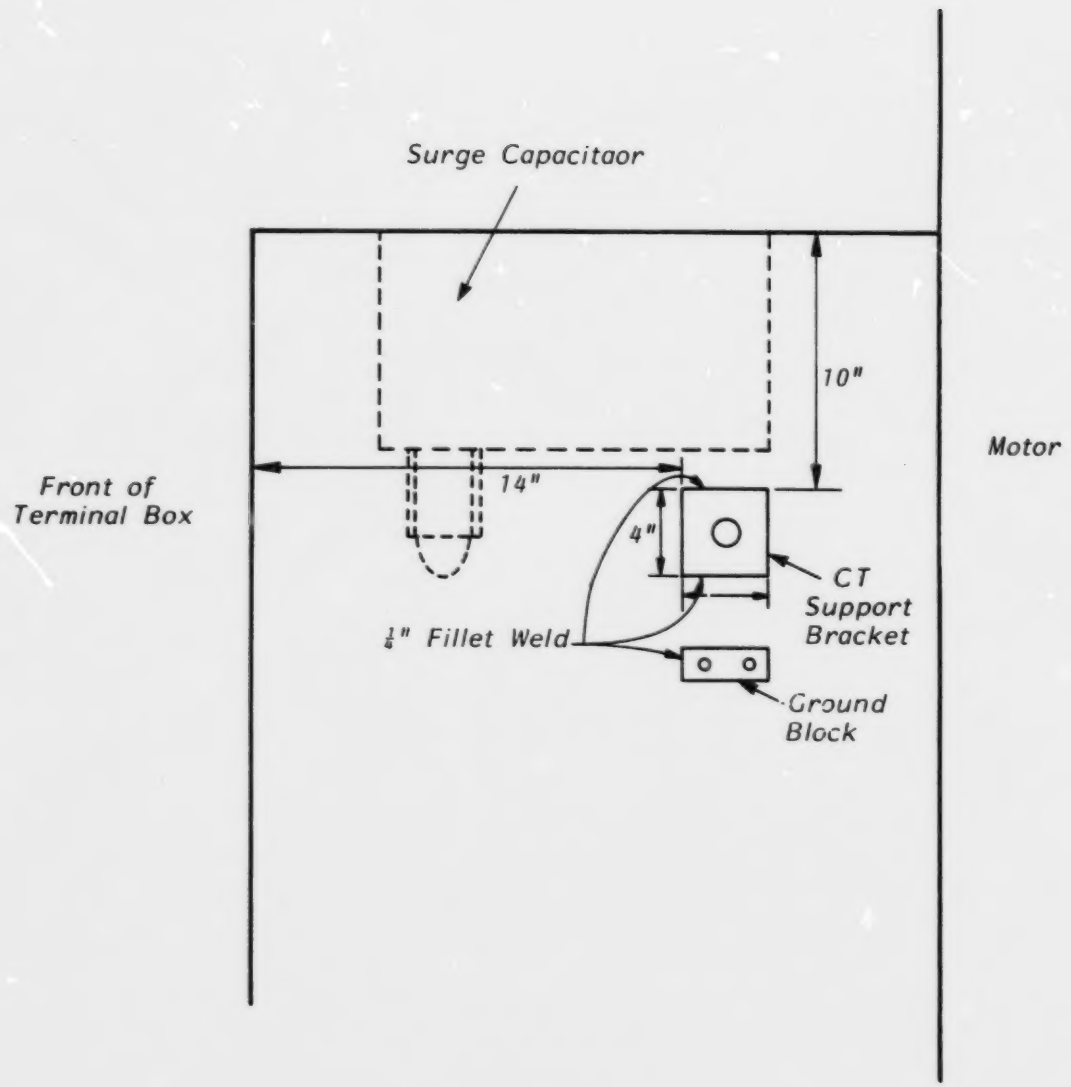

FIGURE 5
TERMINAL BOX SIDE VIEW

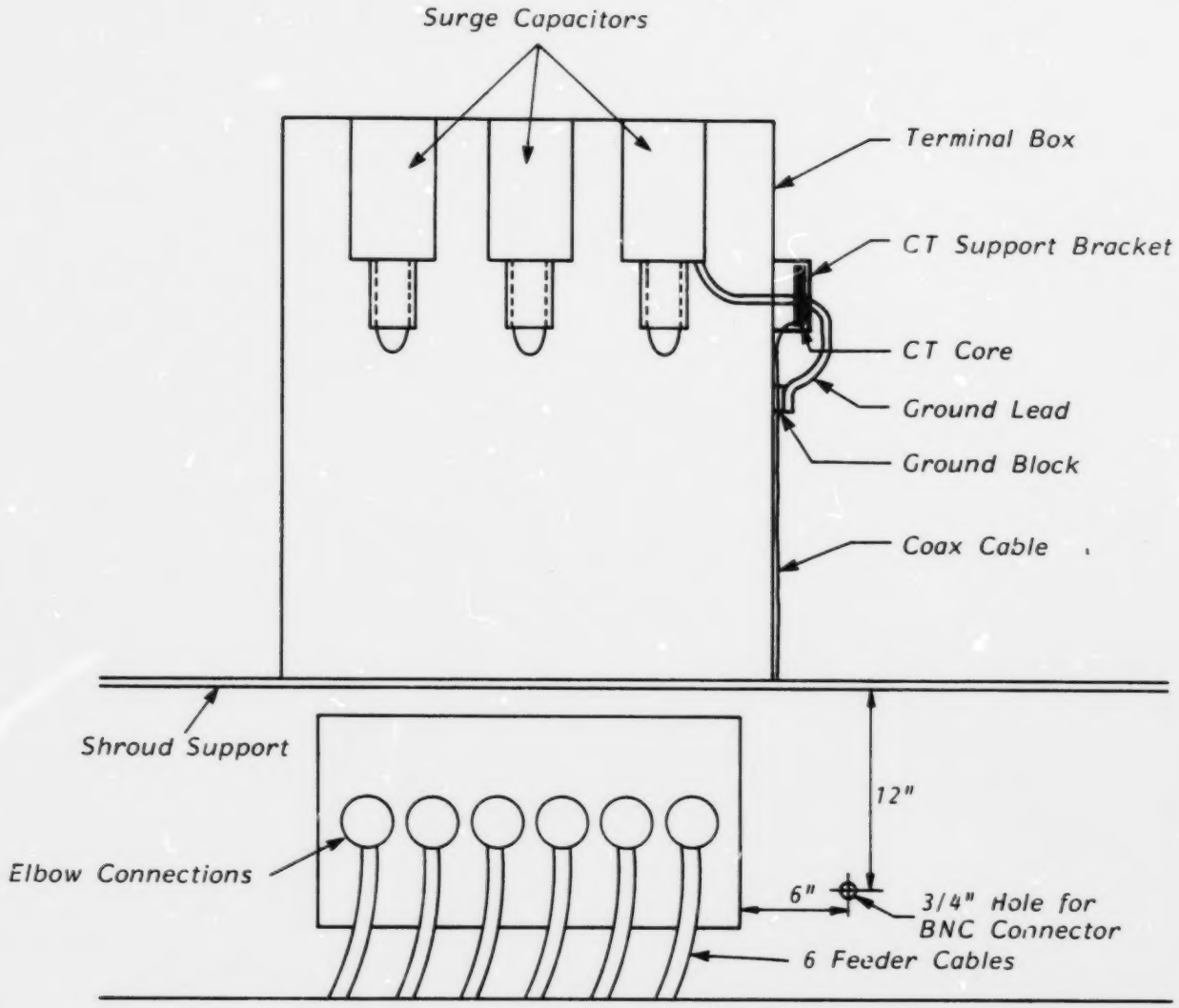

FIGURE 6
FRONT VIEW TERMINAL BOX

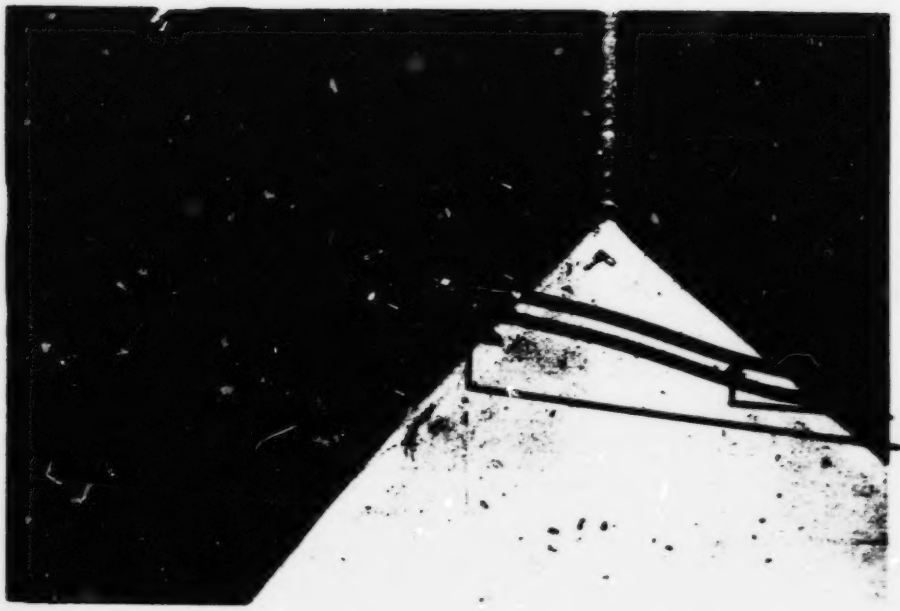

Figure 7

Close up of coax cable connection to BNC bulkhead connector and 1 kΩ resistor.

Figure 8

Coax cable from CT to BNC bulkhead connector.

CT support bracket
Ground lead
Outside ground block
Coax cable and support mounts

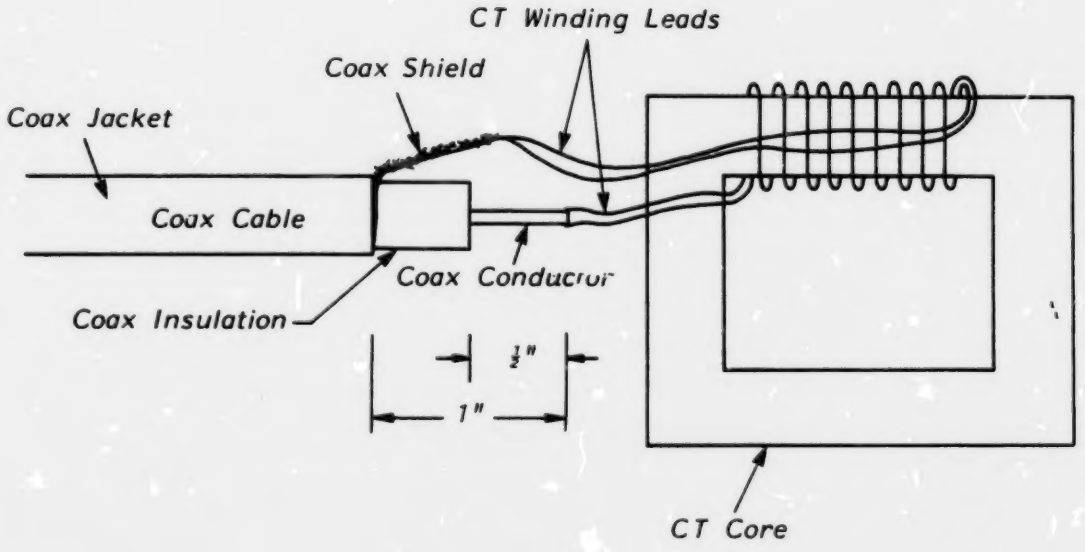

FIGURE 9

COAX CABLE CONNECTION TO CT CORE

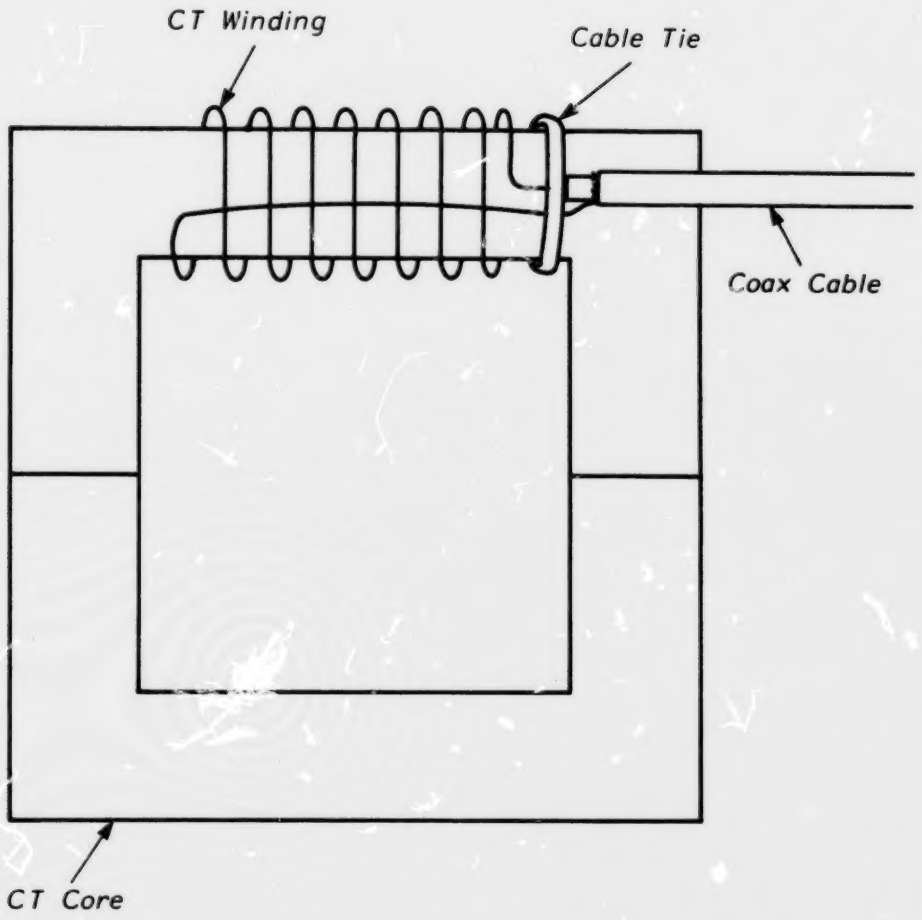

FIGURE 10
COAX CABLE SUPPORT ON CT CORE

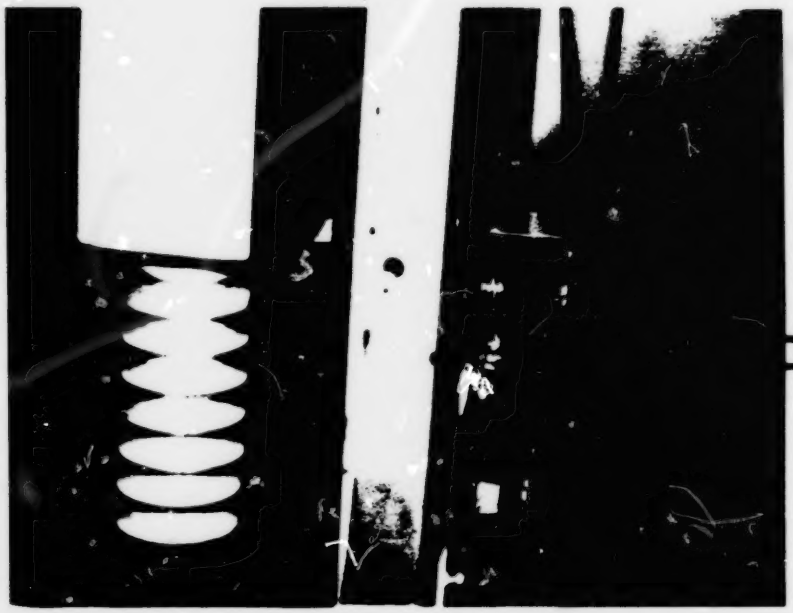

Figure 11

Illustrates ground lead from capacitors through terminal box wall and CT and its support bracket to external ground block.

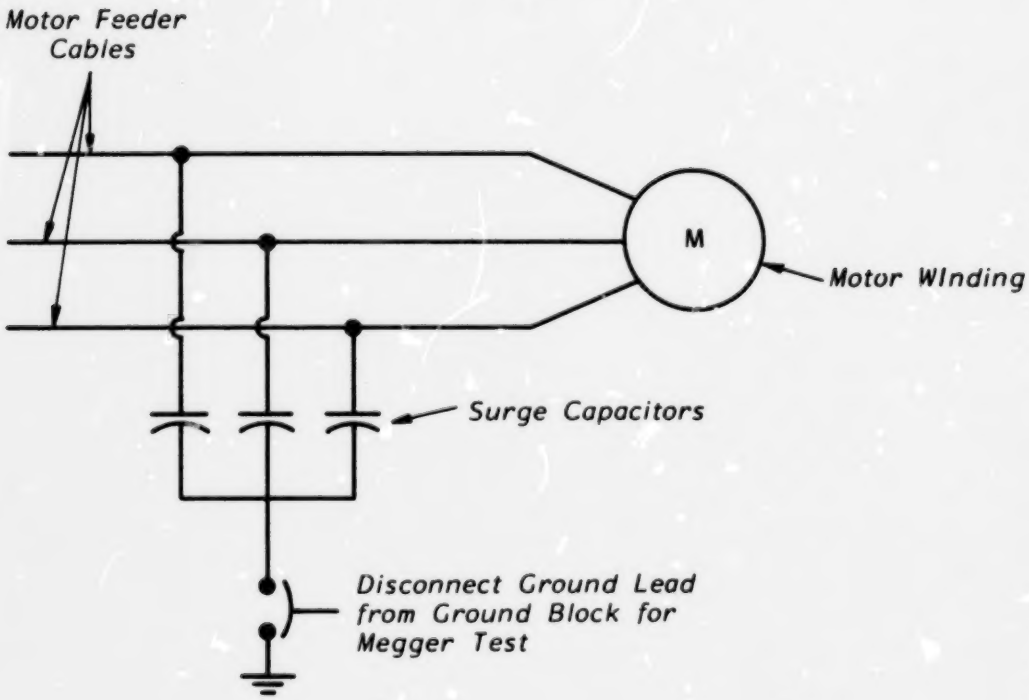

FIGURE 12
MEGGER TEST SETUP

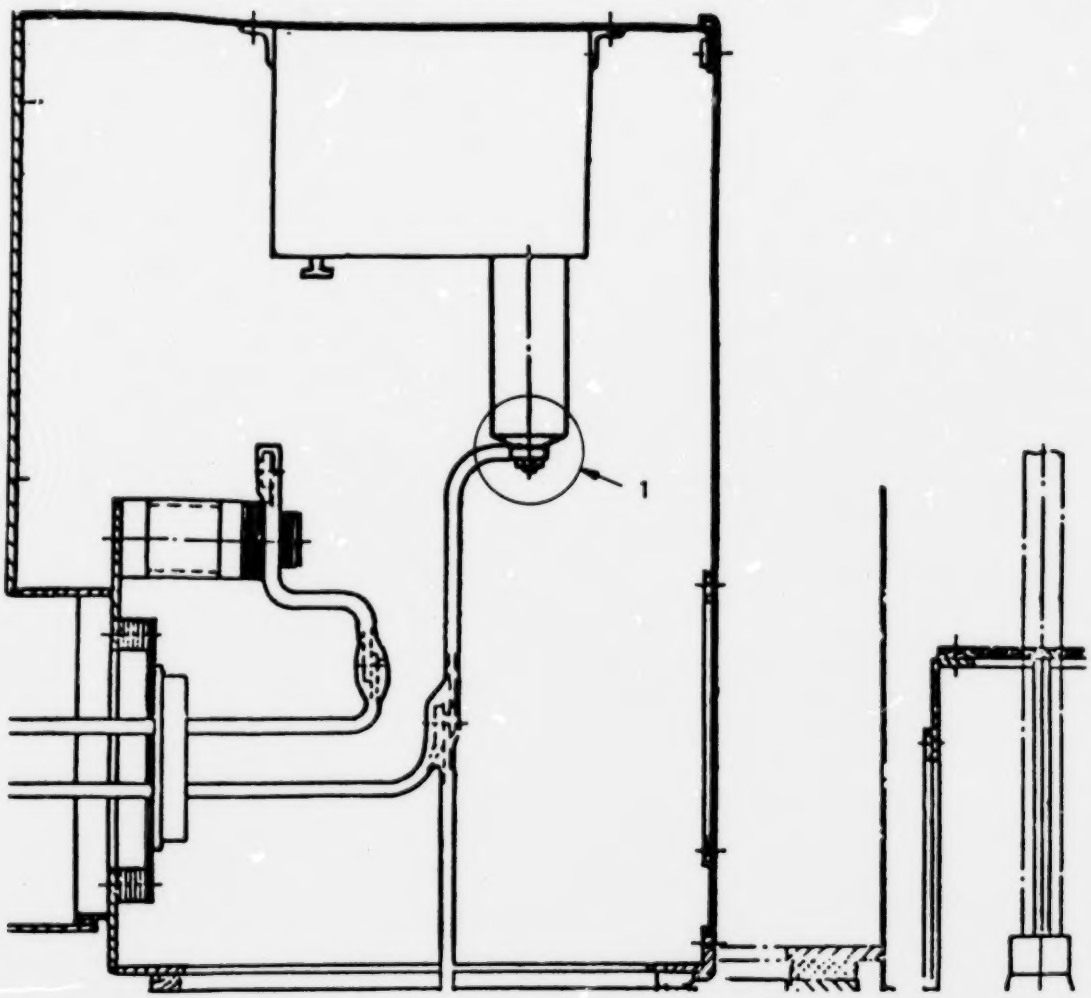

FIGURE 13

CONNECTION POINT FOR MEGGER TESTS

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